

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

STANDING STOCKS OF FISHES IN SECTIONS
OF INDIAN CREEK, PLUMAS COUNTY, 1988

Bay-Delta Project
Contract Services Section

By

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The work was funded by the Department of Water Resources under W. A. 1501.

INTRODUCTION

In 1976, the Department of Water Resources (DWR) initiated an instream flow program to identify streams that would benefit from flow enhancement to assess instream values and identify trade-offs required to enhance these streams. The Northern District of DWR selected Indian Creek below Antelope Reservoir (Figure 1) as one of the streams to study under this program. Initial flow studies by DWR indicated that flow augmentation could double trout habitat in the first 16 km of Indian Creek below the dam and increase habitat by 25% in lower reaches (DWR, 1979). As a result of this study, DWR and the Department of Fish and Game (DFG) decided to reoperate Antelope Reservoir to increase flow releases from 0.1 cms to 0.6 cms year-round on a trial basis. These flows would not impair recreation at Antelope Reservoir.

In 1977, sampling of salmonids was begun in Indian Creek at six different stations. Sampling continued through 1982 on a yearly basis to provide baseline data for salmonid biomasses. The biomasses peaked in 1980 for both brown trout (Salmo trutta) and rainbow trout (Oncorhynchus mykiss). Brown trout biomass averaged 6.0 g/m², rainbow trout biomass averaged 4.4 g/m² (Brown 1978, Brown and Haines 1979, Haines and Brown 1980, Villa and Brown 1981, Villa 1982). Fish were not sampled in 1983, 1984, or 1985. Sampling resumed in 1986. Biomass for brown trout averaged 2.5 g/m² in 1986 and 3.9 g/m² in 1987. Biomass for rainbow trout averaged 1.1 g/m² in 1986 and 2.1 g/m² in 1987. (DFG memo to files March 1989, June 1989).

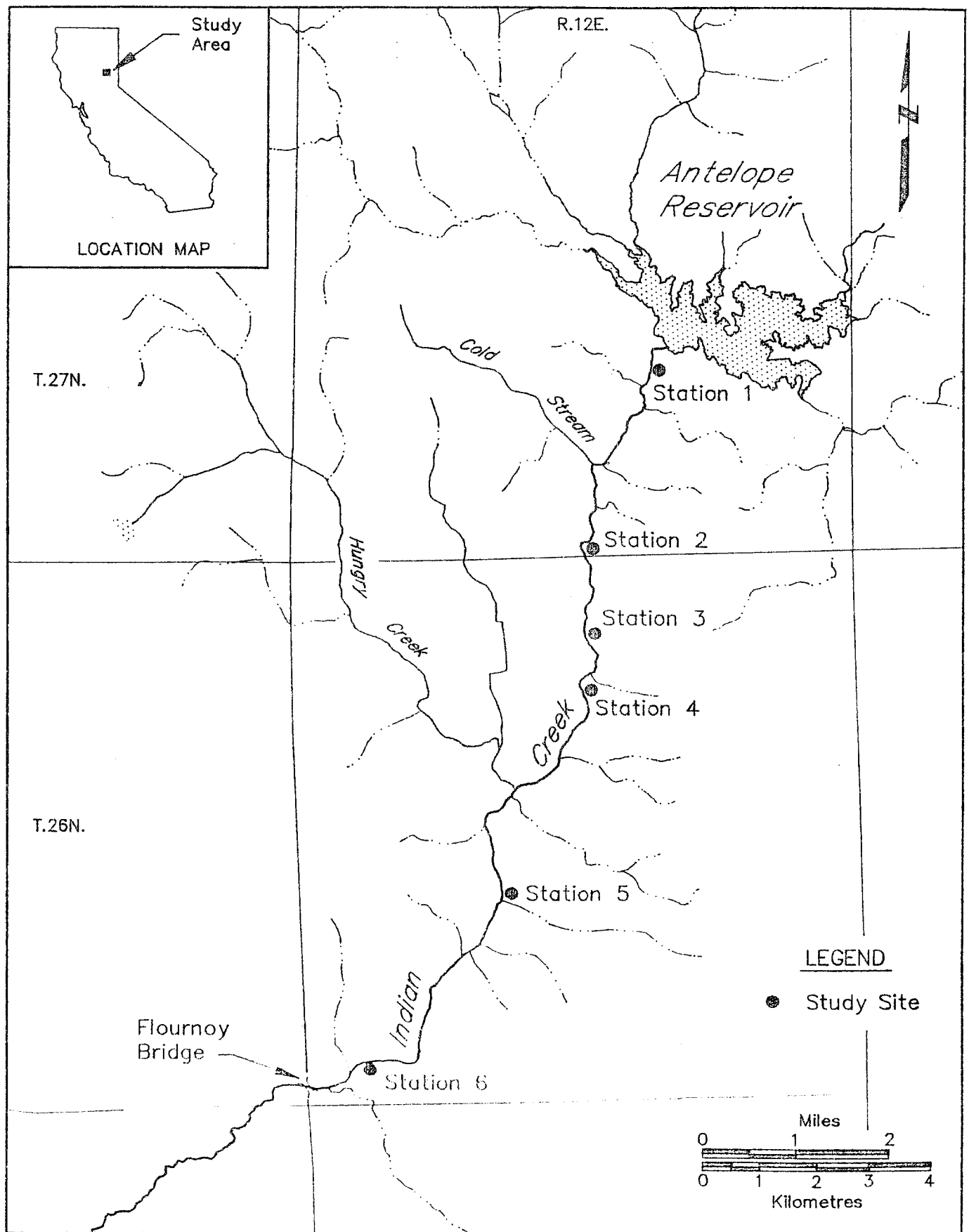


Figure 1—Stations sampled to determine biomass of fishes in Indian Creek, Plumas County, September 1988.

METHODS

Standing stocks of fishes were estimated at six stations in Indian Creek (Figure 1) in Plumas County. Stations were intentionally selected to be near stations sampled in previous DFG studies (Appendix 1). Markers had previously been placed in trees along the stream to identify station boundaries. Stations varied in length from 25.3 to 90 m; the length, average width, and average depth of each station was measured. Fish were captured with a battery-powered backpack electroshocker in stream sections blocked by seines (Appendices 2 and 3). Captured fish were removed from the net-enclosed section on each pass. Standing stock estimates were developed using the two-count method of Seber and LeCren (1967) or the multiple-pass method of Leslie and Davis (1939) with limits of confidence computed using a formula proposed by DeLury (1951).

The weights of brown trout, rainbow trout, and Sacramento sucker (Catostomous occidentalis) were determined by displacement. Weights were measured for all fish caught. Fork length of each fish caught was measured to the nearest millimeter.

Scale samples were taken only from brown trout and rainbow trout over 100 mm in length. Scales were mounted dry between microscope slides, and their images were projected on a NCR microfiche reader at a magnification of 42x. Scale measurements for the calculation of growth were recorded to the nearest millimeter along the anterior radius of the anterior-posterior axis of the scale.

Geometric mean functional regressions were used to describe the body-scale and length-weight relationships (Ricker, 1975). Estimation of true mean growth rate (G) was calculated using methods of Ricker (op. cit.).

Distribution of all fish caught is listed according to location. Standing crops of brown trout and rainbow trout were calculated for individual stations where the species of interest were caught and combined for the entire creek. Age and growth was calculated for the population. Mean individual growth was calculated only for brown trout and rainbow trout. Length-weight relationships were determined for brown trout and rainbow trout in Indian Creek. The coefficient of condition and 95% confidence intervals were calculated for both brown trout and rainbow trout.

RESULTS

Distribution

Brown trout were caught at stations 2 through 6. Rainbow trout were caught at stations 4, 5, and 6. Sacramento suckers were only caught at station six (Table 1).

TABLE 1. Distribution of Fishes in Sections of Indian Creek, Plumas County, 1988

	Station Number					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Distance below Antelope Dam (km)	0.6	3.9	5.3	6.8	12.3	21.0
Brown trout		X	X	X	X	X
Rainbow trout				X	X	X
Sacramento sucker						X

Standing Crop

Brown trout were the most common game fish caught in Indian Creek. Biomass averaged 5.6 g/m^2 at five stations. Biomass for brown trout large enough for fishermen to catch and keep (127 mm FL) averaged 3.3 g/m^2 (Table 2). Rainbow trout biomass averaged 0.6 g/m^2 , while the biomass for catchables averaged 0.4 g/m^2 (Table 3).

Sacramento sucker were the only non-salmonid fish caught in Indian Creek. Biomass was 6.0 g/m^2 for Sacramento sucker (Table 4).

Age and Growth

The formula $L = -2.1 + 4.2 S$ describes the relationship between the fork length (L) and enlarged scale radius (S) of 105 brown trout caught in Indian Creek. The coefficient of correlation (r^2) is 0.81. The formula was $L = 50.3 + 3.5 S$ for 10 rainbow trout caught in Indian Creek, while the value for r^2 is 0.66.

Population growth rate for 2+ brown trout was faster than age 2+, but mean individual growth was faster in 2+ trout.

Age 1+ rainbow trout had faster growth rates for mean individual growth than population growth.

TABLE 2. Estimate of Brown Trout Standing Crop in Indian Creek, Plumas County, 1988

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m ²	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m ²
0.6					
3.9	141	125-157	6.4	16	2.7
5.3	325	292-358	9.6	44	6.0
6.8	503	487-519	9.3	34	4.7
12.3	17	15-19	0.5	4	0.6
21.0	4	0-11	2.4	4	2.4
			X = 5.6 g/m ²	X = 3.3 g/m ²	

TABLE 3. Estimates of Rainbow Trout Standing Crop in Indian Creek, Plumas County, 1988

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m ²	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m ²
6.8	1	1-1	0.1	1	0.1
12.3	13	12-14	0.8	-	-
21.0	2	2-2	0.8	2	0.8
			X = 0.6 g/m ²	X = 0.4 g/m ²	

TABLE 4. Estimate of Standing Crop of Nongame Fishes in Indian Creek, Plumas County, 1988

Distance Below Antelope Dam (km)	Species	Population Estimate	95% Confidence Interval	Biomass g/m ²
21.0	Sacramento sucker	6	6-6	0.18

TABLE 5. Growth Rates for Brown Trout Caught in Indian Creek, Plumas County, 1988

Age Interval	Population Growth			Mean Individual Growth		
	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	74-195	0.969	0.806	85-195	0.830	0.691
2-3	195-244	0.224	0.443	159-244	0.428	0.847

TABLE 6. Growth Rates for Rainbow Trout Caught in Indian Creek, Plumas County, 1988

Age Interval	Population Growth			Mean Individual Growth		
	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	105-165	0.452	0.343	92-165	0.584	0.443

Age 1+ brown trout averaged 158 mm in fork length; 2+ and 3+ fish averaged 263 and 298 mm, respectively (Table 7).

Age 1+ and 2+ rainbow trout measured 163 and 226 mm, respectively (Table 8).

TABLE 7. Calculated Fork Length in Millimetres of Brown Trout from Indian Creek, Plumas County, 1988

Age	No. of Fish	Length at Capture (mm)	Calculated Lengths at Successive Annuli		
			1	2	3
1	85	158	74	-	-
2	11	263	85	195	-
3	9	298	78	159	244
Number of back-calculations			105	20	9
Weighted means (mm)			75	179	244
Increments (mm)			75	104	65

TABLE 8. Calculated Fork Length in Millimetres of Rainbow Trout from Indian Creek, Plumas County, 1988

Age	No. of Fish	Length at Capture (mm)	Calculated Lengths at Successive Annuli	
			1	2
1	5	163	105	-
2	3	226	92	165
Number of back-calculations			8	3
Weighted means (mm)			100	165
Increments (mm)			100	65

Length and Weight

Age group 0+ brown trout represented 89% of the catch. Ages 1+ and 2+ fish represented 9% and 1%, respectively, while 3+ fish made up 1% (Figure 2).

Age group 0+ rainbow trout represented 47% of the catch. Ages 1+ and 2+ fish made up 37% and 16%, respectively (Figure 3). (Appendices 2 and 3).

The relationship between length (L) and weight (W) of brown trout is:

$$\text{Log}_{10}W = -4.39 + 2.70 \text{ Log}_{10}L$$

$$r^2 = 0.90$$

$$N = 923 \text{ (Figure 4)}$$

The same relationship for rainbow trout is:

$$\text{Log}_{10}W = -4.82 + 2.94 \text{ Log}_{10}L$$

$$r^2 = 0.99$$

$$N = 19 \text{ (Figure 5) (Appendices 4 and 5 respectively)}$$

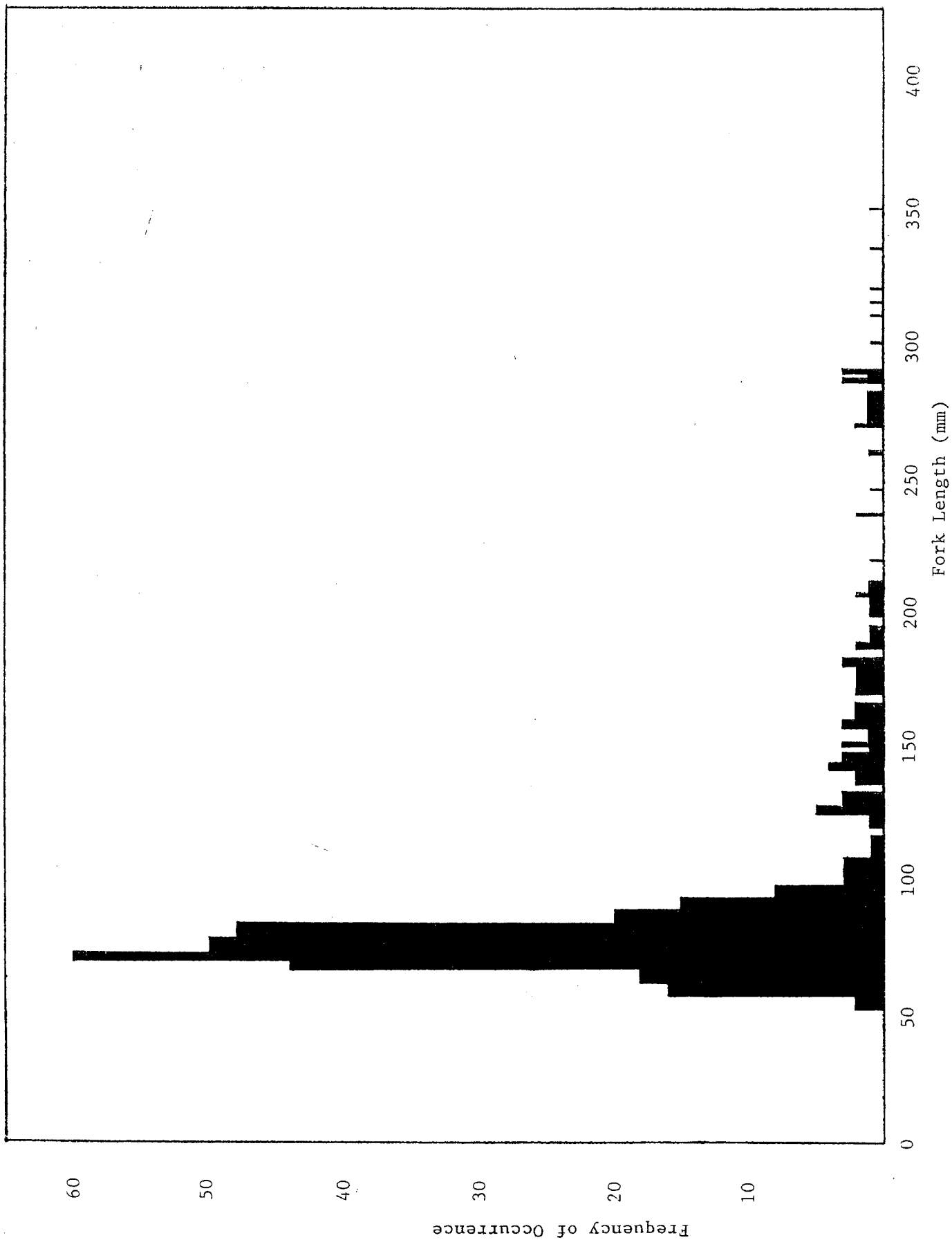


FIGURE 2 Length, observed frequency, and age of brown trout caught in Indian Creek, Plumas County, 1988.

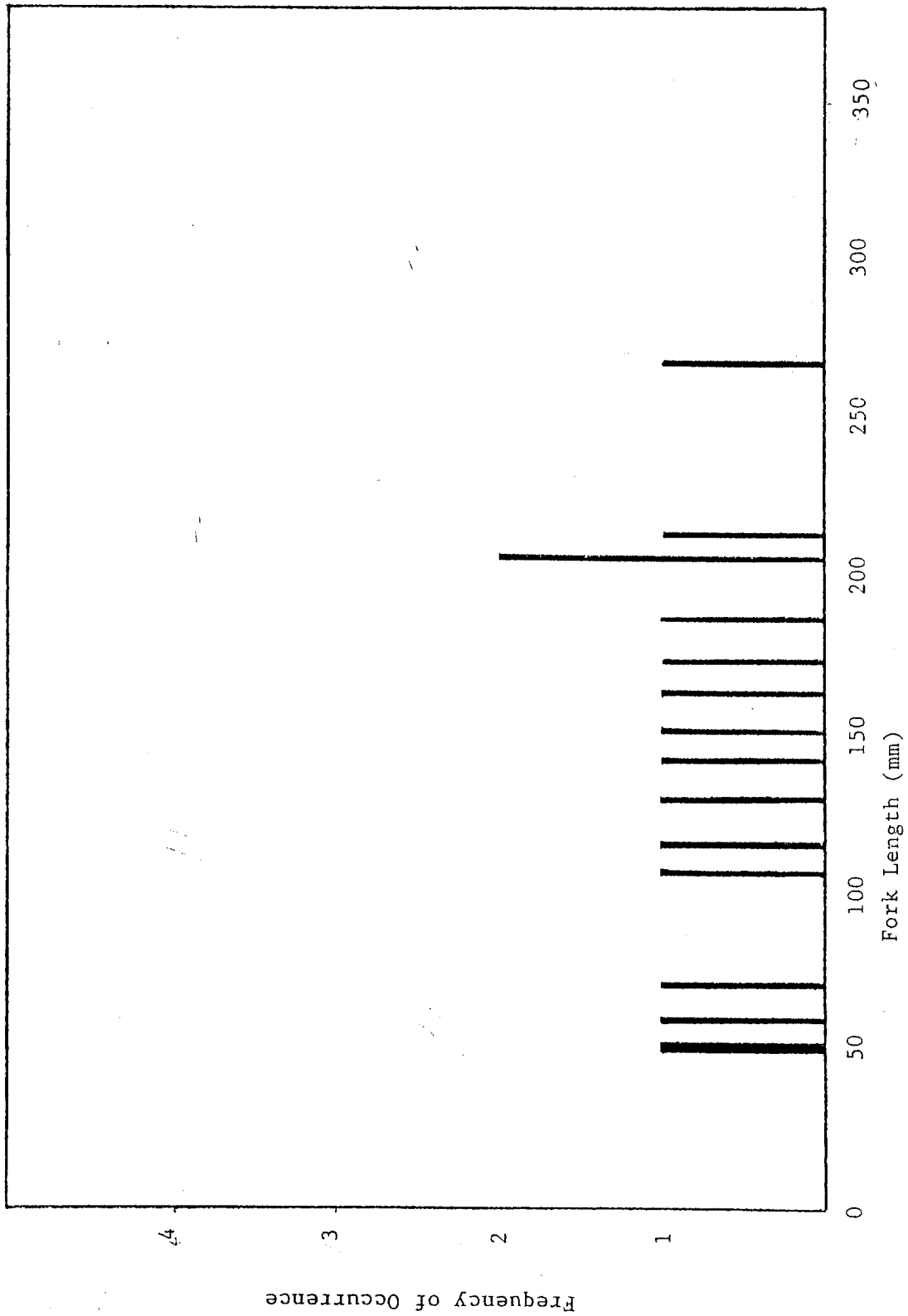


FIGURE 3 Length, observed frequency, and age of rainbow trout caught in Indian Creek, Plumas County, 1988.

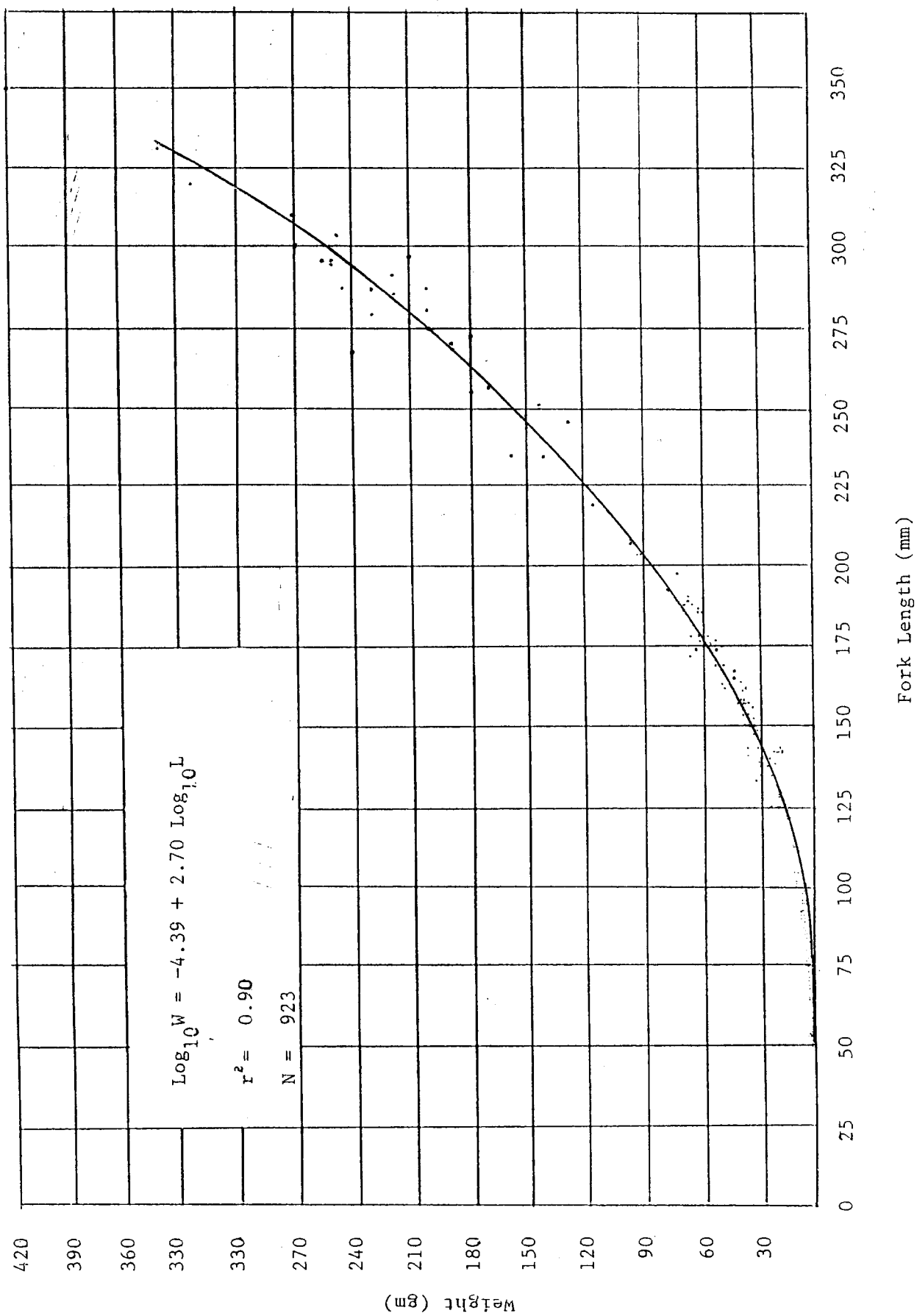


FIGURE 4 The relationship between length and weight of brown trout caught in sections of Indian Creek, Plumas County, 1988.

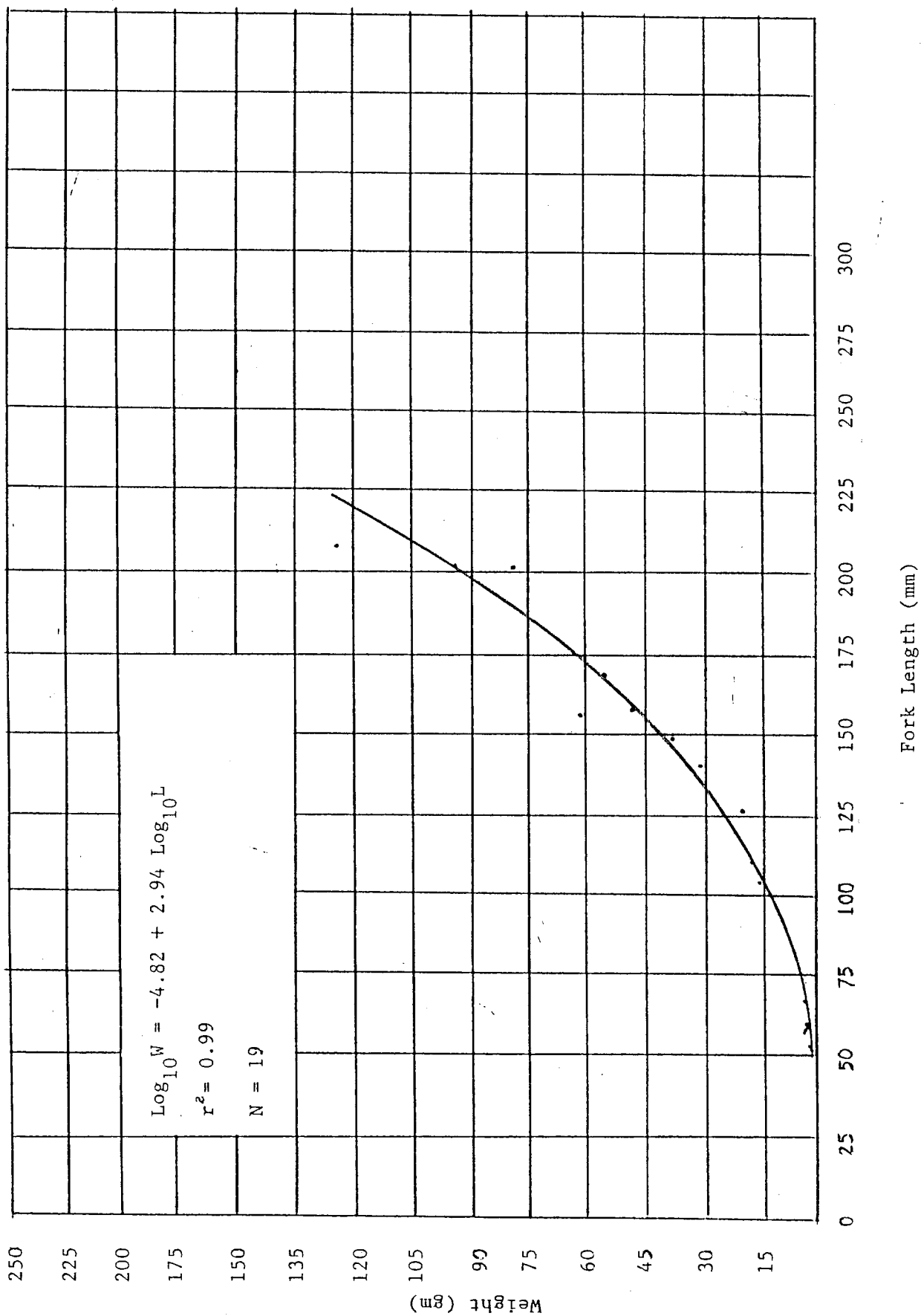


FIGURE 5 The relationship between length and weight of rainbow of rainbow trout caught in sections of Indian Creek, Plumas County, 1988.

Coefficient of Condition

We calculated the coefficient of condition and 95% confidence limits for a total of 923 brown trout and 19 rainbow trout (Table 9). There is no significant difference between the coefficient of condition for any age group of brown trout or rainbow trout we tested ("t" test, 0.05 level).

TABLE 9. Condition of Brown Trout and Rainbow Trout in Indian Creek, Plumas County, 1988

Age Group	Number of Fish	Coefficient of Condition	95% Confidence Interval
Brown trout			
0+	807	1.0761	0.8394-1.3128
1+	85	1.0496	0.9580-1.1412
2+	11	0.9871	0.8888-1.0854
3+	9	0.9927	0.9270-1.0584
Combined*	923	1.0613	0.8289-1.2935
Rainbow trout			
0+	2	1.0863	1.0252-1.1474
1+	5	1.1757	1.0026-1.3488
2+	3	1.1002	0.8806-1.3198
Combined**	19	1.1595	1.0000-1.3190

* We were unable to age eleven brown trout from scale samples, but they were included in the combined coefficient of conditions and 95% confidence interval.

** Nine rainbow trout could not be aged.

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APPENDIX 1

PERMANENT FISH POPULATION STATIONS
FOR INDIAN CREEK, PLUMAS COUNTY
SEPTEMBER AND OCTOBER 1988

APPENDIX 1

PERMANENT FISH POPULATION STATIONS INDIAN CREEK, PLUMAS COUNTY SEPTEMBER AND OCTOBER 1988

Indian Creek has had two periods of very high runoff (late May 1983 and mid-February 1986). High flows during these periods severely eroded streambanks in meadow sections of the creek, toppled many trees into the creek, deposited large quantities of sand and gravel, and rerouted the stream channel in many locations. Thus, although three of the six stations sampled in 1986 and 1987 are the same locations sampled in previous years, none of the stations are truly comparable to those sampled in previous years. One of the new stations (6A) was picked because it appears to be similar to the station it replaced; the other two (3A and 4A) are quite different from the old stations but seem to represent typical habitat in those portions of the creek.

Station 1 - Located 0.6 stream km below Antelope Dam adjacent to the picnic area near the junction of Indian Creek Road and the spur road leading to the base of the dam (NE 1/4 of NE 1/4, Section 27, T27N, R12E). Although there is some erosion along the left bank, and evidence of a few inches of channel degradation, this station appears to be similar to 1978 and 1979 before beaver dams flooded the lower portion of the station. The station consists of a pool and run area (47%) between two riffles (53%). It is 94.8 m long and has a surface area of 561 m² and a volume of 140.3 m³ at 0.56 cms.

Station 2 - Located 4.7 below Antelope Dam, 1.9 km below Cold Stream, and about 13.3 km above Flourney Bridge (SW 1/4 of SW 1/4, Section 34, T27N, R12E). The station is 25.3 m long, marked by a 36-cm-diameter alder (RB) and a 10-cm-diameter pine, both with metal disks now barely visible from the road. This station looks similar to previous years. It contains riffle (58%) run (30%) and pool (12%) areas. The station has a surface area of 202 m² and a volume of 50 m³ at 0.56 cms.

Station 3 - Located about 6.1 km below Antelope Dam, 1.3 km above Babcock Crossing, and 11.9 km above Flourney Bridge (NW 1/4 of NW 1/4, Section 10, T26N, R12E). This station replaces one just downstream which has been eroded into a deep pool too lengthy to electrofish. The new station has two pools (22%) separated by runs (30%) and riffles areas (48%). There are several downed trees on the eroded LB. Unlike the station it replaces, this station has little shade. The new station is 66.4 m long and has a surface area of 315.4 m² and a volume of 76.3 m³ at 0.56 cms.

Station 4 - Located about 7.3 km below Antelope Dam, 0.1 km above Babcock Crossing, and 10.7 km above Flourney Bridge (NW 1/4 of SW 1/4, Section 10, T26N, R12E). This new station is located about 0.1 m downstream from the previous station and about halfway between Babcock Crossing and a parking turnout 0.3 km upstream. The station contains two small pools (50%) separated by riffles areas (29%) and a run (21%). Like the station it replaces, it is mostly unshaded. The station is 59.7 m long and has a surface area of 455 m² and a volume of 149 m³ at 0.56 cms.

Station 5 - Located near an unimproved campground about 12.0 km below Antelope Dam and 6.0 km above Flournoy bridge (NW 1/4 of SW 1/4, Section 21, T26N, R12E). Recreational gold-dredging has drastically altered the old station 5 making it unrepresentative of fish habitat in this area. In 1988, we moved the station about 200 m upstream to a more representative area. The new station is reached from the same paved access road by following a dirt road that extends upstream to a campsite near the creek. The station extends ___ m downstream from the rapid adjacent to the campsite. It contains riffle, pool and shallow run area. Riffle area is 46%, pool area 13%, and run area 41%. The station has a surface area of 337.5 m² and a volume of 75.6 m² at 0.56 cms.

Station 6 - Located about 1.0 km above Flournoy Bridge and about 17.0 km below Antelope Dam (NE 1/4 of SW 1/4, Section 31, T26N, R12E). (Drive 0.3 km east of Flournoy Bridge on the Indian Creek road and take the paved spur road to the right 0.6 km to a gate in the fence on the right side of the road where the creek turns south from the road. Follow a trail along the streambank downstream about 35 m.) The lower end of the station is located at a steep rapid at the lower end of the alders where the streambed widens abruptly. The new station is located just upstream of the original station, which was greatly changed by the February 1986 flood. The station is a rocky run with several small pockets of slow water and undercut bank on RB. Riffle area totals 28%, run area 37%, and pool area 35%. The station is 32.9 m long with a surface area of 172.5 m² and a volume of 38 m³ at 0.56 cms.

APPENDIX 2
LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1988

APPENDIX 2

LENGTH AND NUMBER OF BROWN TROUT CAUGHT IN INDIAN CREEK, 1988

Fork Length (mm)	Number	Fork Length (mm)	Number
50	2	102	2
52	1	103	1
53	1	105	3
54	1	108	1
55	16	111	1
56	6	112	1
57	7	114	1
58	12	115	1
59	7	119	1
60	18	122	1
61	15	123	1
62	10	124	2
63	18	125	5
64	14	126	1
65	44	128	2
66	21	129	1
67	27	130	3
68	20	134	1
69	29	135	2
70	60	137	2
71	22	138	1
72	20	139	1
73	41	140	3
74	26	142	4
75	50	144	1
76	14	145	3
77	14	146	1
78	27	147	1
79	29	149	1
80	48	150	3
81	13	152	1
82	17	153	1
83	13	154	1
84	12	156	1
85	20	158	3
86	15	159	1
87	13	160	2
88	8	162	1
89	5	163	2
90	15	164	2
91	5	165	1
92	11	169	2
93	8	170	2
94	7	171	1
95	8	172	1
96	1	174	2
97	3	175	2
98	2	176	1

APPENDIX 2 (Cont'd.)

LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1988

Fork Length (mm)	Number
178	2
180	3
183	1
185	2
187	1
188	2
190	1
192	1
193	1
197	1
205	2
208	1
210	1
218	1
235	2
245	1
253	1
258	1
260	1
269	2
272	1
273	1
275	1
279	1
280	1
281	1
285	3
288	1
289	1
290	3
300	1
310	1
315	1
320	1
335	1
350	1

APPENDIX 3

LENGTH AND NUMBER OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, 1988

APPENDIX 3

LENGTH AND NUMBER OF RAINBOW TROUT CAUGHT IN INDIAN CREEK, 1988

Fork Length (mm)	Number
51	1
52	1
59	1
60	1
70	1
105	1
114	1
127	1
140	1
149	1
163	1
171	1
184	1
203	2
210	1
264	1

APPENDIX 4

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1988

APPENDIX 4

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1988

<u>Fork Length (mm)</u>	<u>Weight (g)</u>	<u>Fork Length (mm)</u>	<u>Weight (g)</u>
50	1,2		
52	1.5	80	14(5),21(5.5)11(6),
53	1.5		1(6.5),1(7)
54	1.5	81	1(5),5(5.5),6(6),
55	1,1.5,1.5,1.5,1.5		1(6.5)
	11(2)	82	2(5.5),9(6),
56	5(2),1(3)		5(6.5),1(7)
57	2(1.5),4(2),1(2.5)	83	1(5.5),3(6),6(6.5),
58	11(2),1(2.5)		3(7)
59	5(2),2(2.5)	84	4(6),7(6.5),1(7)
60	8(2),5(2.5),5(3)	85	1(5),2(6),3(6.5),
61	4(2),8(2.5),3(3)		7(7),6(7.5),1(8)
62	3(2),5(2.5),2(3)	86	6,2(6.5),7(7),5(7.5)
63	12(2.5),6(3)	87	2(6.5),3(7),6(7.5),
64	1(2),6(2.5),7(3)		1(8),1(8.5)
65	14,(2.5),28(3),	88	6.5,2(7),2(7.5),3(8)
	1(3.5),1(4)	89	6.5,7,7.5,2(8)
66	1(2),1(2.5),14(3),	90	7,2(7.5),4(8),
	4(3.5),1(4)		5(8.5),3(9)
67	2(2.5),10(3),	91	7.5,8,8.5,9,9.5
	13(3.5),1(4),1(5)	92	2,7,2(8),2(8.5),5(9)
68	11(3),6(3.5),2(4),	93	3(8),8.5,9,9.5,2(10)
	1(5)	94	8.5,3(9),3(9.5)
69	1(2),12(3),12(3.5),	95	8,8.5,3(9.5),3(10)
	4(4)	96	10.5
70	3(3),40(3.5),16(4),	97	8,10,10.5
	1(4.5)	98	2(10)
71	10(3.5),9(4),2(4.5),	102	11,12
	1(5)	103	12.5
72	1(3),6(3.5),8(4),	105	13,13.5,14
	4(4.5),1(5)	108	13
73	3(3.5),29(4),6(4.5),	111	14
	1(5)	112	15
74	2(3.5),7(4),11(4.5),	114	15
	4(5),2(5.5)	115	14
75	2(3.5),10(4),	119	19
	21(4.5),15(5),1(5.5)	122	18
76	2(4),4(4.5),6(5),	123	19
	2(5.5)	124	2(18)
77	2(4.5),9(5),	125	2(20),21,22,24
	2(5.5),1(6)	126	21
78	2(4),5(4.5)	128	20,23
	9(5),9(5.5),2(6)	129	23
79	1(4),1(4.5),14(5),	130	23,24,25
	9(5.5),3(6),1(6.5)	134	32

APPENDIX 4 (Cont'd)

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1988

<u>Fork Length (mm)</u>	<u>Weight (g)</u>	<u>Fork Length (mm)</u>	<u>Weight (g)</u>
135	26,30	235	140,160
137	25,30	245	130
138	26	253	144
139	31	258	180
140	27,28,30	260	170
142	28,31,32,33	269	190,240
144	28	272	190
145	23,31,36	273	180
146	32	275	200
147	34	279	230
149	32	280	200
150	34,37,38	281	220
152	37	285	200,230,245
153	42	288	220
154	40	289	250
156	37	290	210,255,260
158	40,42,47	300	270
159	41	310	250
160	43,44	315	270
162	41	320	320
163	39,47	335	340
164	44,51	350	420
165	46		
169	2(46)		
170	48,53		
171	52		
172	68		
174	53,65		
175	50,57		
176	55		
178	52,61		
180	58,62,65		
183	65		
185	60,63		
187	62		
188	66,70		
190	70		
192	67		
193	78		
197	75		
205	92,93		
208	95		
210	95		
218	115		

APPENDIX 5

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, 1988

APPENDIX 5

LENGTH AND WEIGHT OF RAINBOW TROUT CAUGHT IN INDIAN CREEK, 1988

Fork Length (mm)	Weight (g)
51	1.5
52	1.5
59	3
60	2.5
63	3
70	3.5
105	15.5
114	17
127	21
140	31
149	38
160	61
163	50
171	55
184	75
203	95
203	80
210	125
264	150